Planning Joint Vietnam Ocean Circulation Studies

Luca Centurioni
Scripps Institution of Oceanography
9500 Gilman Drive
Mail Code 0213
La Jolla, California 92103
phone: (858) 534-6182 email: lcenturioni@ucsd.edu

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LONG-TERM GOALS

The overall goals are to:

1) Contribute to the study of coastal and open ocean current systems in sparsely sampled regions such us the South China Sea (SCS), using a Lagrangian approach;
2) Make significant improvement of observational tools that have wide strategic and operational NAVY application;
3) Foster partnership with Vietnamese scientists.

OBJECTIVES

We intend to make new Lagrangian and Eulerian observations to measure the seasonal circulation 1) in the coastal waters of Vietnam and 2) in the SCS at times and locations where only sparse direct current observations exist today. These data will also be used to test and improve hydrodynamic circulation models of the SCS and its coastal waters.

Raise interest amongst Vietnamese scientists on Lagrangian circulation studies through multiple visits to Vietnam. The goals of the visits are to support ONR activities, to present our scientific results based on the analysis of drifter data in the region and to offer a practical demonstration of drifter technology.

APPROACH

1) Participate in the bilateral US-Vietnam planning workshops and share our expertise on the circulation of the South China Sea and Gulf of Tonkin.
2) Spin-up the fabrication of SVP drifters at the Scripps Institution of Oceanography
3) Add technical improvements to the River Drifter and design a field-test program for those improvements.

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WORK COMPLETED

Visits to Vietnam

1) Dr. Luca Centurioni visited Vietnam in November 2010 to attend a series of meetings with Vietnamese scientists and functionaries. Visited Ho Chi Min City to attend a US-Vietnam joint workshop, Nah-trang, Hanoi and Hai-Pong. He presented his scientific results in the South China Sea and the River Drifter technology.
2) Dr. Centurioni travelled to Hanoi in September 2011 to attend the workshop on International Cooperation on Investigation and Research of Marine Natural Resource and Environment". He presented an overview of the Global Drifter Program and of the River Drifter technology.
3) Dongkyu Lee participated the pre-planning meeting with Vietnamese scientists on May 21-23, 2012 at Halong Bay. The scientific results in the South China Sea from the Global Drifter Program (GDP) were presented to the Vietnamese scientists. A River Drifter was presented to the Vietnamese scientists.
4) Dongkyu Lee and Lance Braasch (engineer) participated the training sessions onboard R/V Revelle at Da Nang on June 23-27, 2012. All the details of the surface drifter and river drifter were presented to the Vietnamese scientists.

Luca Centurioni and Dongkyu Lee contacted Dr. Vo Luong Hong Phuoc (vlhphuoc@phys.hcmuns.edu.vn) at Hanoi University for the logistic support of drifter program. Dr. Phuoc will help the drifter program to clear custom, store and deliver drifters to the Hyundai ship when the ship arrives at the Hanoi port.

Dongkyu Lee contacted the Korea Hydrographic and Oceanographic Administration (KHOA) and the Hyundai Shipping Co. for the cooperation of drifter program in the South China Sea. KHOA will write the letter to the Hyundai Shipping Co. for the drifter deployment in the South China Sea.

Technical development: River Drifter

- GPS:

Upon completion of the prototype stage of development, it had been determined that the electronics package should be transitioned from a standalone GPS board (Navman model: J31) to an integrated chipset based receiver (U-Blox model: Neo-6Q). In changing to the similarly priced U-Blox chipset module, the RD is capable of sampling GPS up to 5Hz (previously fixed at 1 Hz).

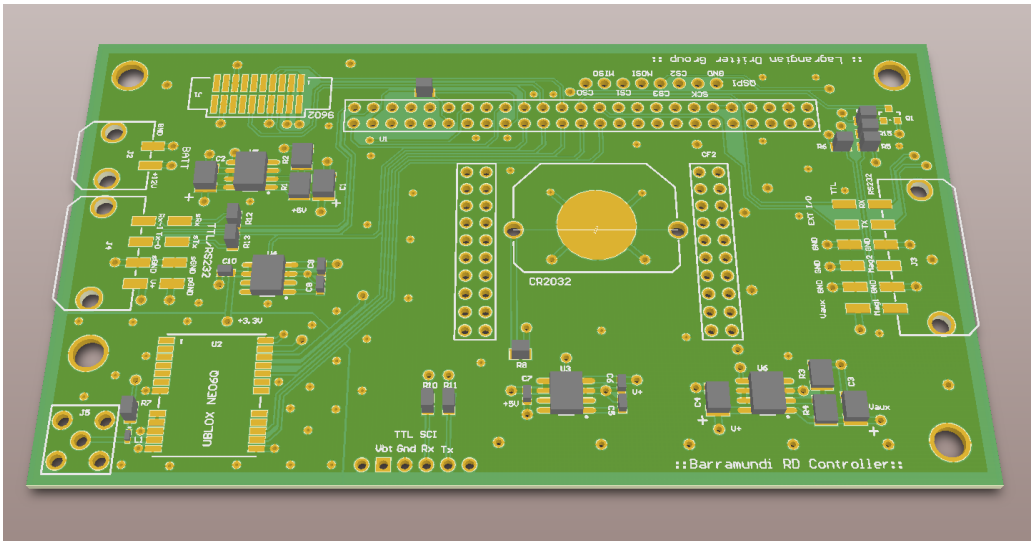

Figure 1: RD CF2 daughter board

Figure 2: RD daughter board assembled and paired with host CF2

- Persistor CF2 Daughterboard:

A printed circuit board (PCB) was designed in-house for the Persistor CF2 micro-controller unit (MCU). The daughter board replaced the prototype daughterboard and consolidates the GPS module, bluetooth module, power distribution and supporting circuits to a single PCB. The new design minimizes maintenance errors by decreasing the number of components within the electronics package.

Figure 3: Complete RD electronics chassis. Not shown: 9602 SBD modem and antennae splitter.

- ADCP:

In addition to the 1 and 2 MHz downward facing ADCP systems with a bottom pinger, a Nortek High Resolution upward facing Slip ADCP was added to the River drifter fleet.

It had been determined through prototype testing that a bug was present on the Nortek firmware for the 1 and 2 MHz ADCP units. Therefore, in preparation for the experiment Milonga, Italy, organized by Dr, Pierre Poulain,, Nortek advised SIO to take precautionary measures due to the unpredictable ADCP behavior. The firmware bug was evaluated by Nortek and determined to be caused by the bottom-pinger averaging scheme. A patched firmware has since been provided by Nortek.

- System Firmware:

The SIO developed RD firmware has numerous additions to the original RD capabilities. Previously, the RD system was limited to 1 Hz sampling of GPS and ADCP data, with Iridium Short Burst Data (SBD) transmissions at a fixed schedule of 10 minutes. The refurbished firmware enables dynamic programming of the ADCP and two way Iridium communications for modifying mission parameters remotely. Precautionary measures were added to ensure the drifter does not completely drain the battery such that the unit becomes unrecoverable.

- Batteries and Power consumption:

The RD refurbishment included a 10 Amp-hour (Ah) NiMh pack. The previous battery was a 5 Ah NiMh pack. Additionally, the battery charging circuit was modified to allow rapid charging with indication of charge completion. Power conservation methods include dynamic programming of SBD transmission schedule, ADCP sampling as well as upgrade to the NAL Iridium 9602 SBD modem.

Technical Development: SVP drifter

In consideration of the modularity of the SVP drifter platform, a complete SVP platform was developed in-house at SIO with Global Drifter Program funds. The hardware platform was developed with a re-sealable surface float and strain relief utilizing injection molding technology. Additionally, an inexpensive micro-controller unit (MCU) was designed with support circuitry for onboard GPS,

SST, drogue detection, external barometer, multiple satellite communication systems, and other developmental sensors. Field tests were conducted in Milogna, Italy, British Columbia, Canada, as well as short-term tests off the coast of San Diego, California to evaluate system performance in the field. However, because of the special need for many ONR experiments of high-resolution locations, two Iridium GPS drifters were designed, built and tested at SIO, with funds from this project.

***Field Work**:*

- Milonga, Italy: October 11-13 2011

Given the difficulty of accessing the target deployment area (Mekong river delta) due to the slow progress of the US/Vietnam joint research, it was decided to find another testbed location that would offer concurrent observations to put the RD data in context. A suitable opportunity was identified in the fieldwork campaign "Milonga" run by Dr. Pierre Poulain in the Tyrrhenian Sea. Three RD systems (2x 1 MHz, 1x Slip ADCP) were sent to Piombino, Italy for an experiment in the North Tyrrhenian Sea. A Slip ADCP and 1 MHz RD were deployed. Due to issues with the ADCP and GPS antenna, the deployment was shorted to 3 days.
Two Dogfish controller based Iridium SVP systems were also sent to Piombino, Italy. The drifters were deployed and left to freely drift until reaching their end of life.

- Da Nang, Vietnam: June 23-29 2012

Two RD units were sent to Da Nang, Vietnam to contribute to the technical demonstrations of the R/V Revelle capabilities. Due to restrictions set in place by the Vietnamese government, no drifters were deployed. Instead, the hardware package, and electronics assembly were demonstrated to the Vietnamese guests. Additionally, sensor capabilities of the SVP drifter platform were presented.

RESULTS

Milonga Experiment, Piombino, Italy:

Post deployment, Nortek analyzed the RD ADCP file recorder. The dataset from the North Tyrrhenian Sea was recovered from the 1 MHz ADCP, the results of which are shown below. The analysis of the slip RD is postponed as ancillary data such as wind speed and direction are required to interpret the results.

The 1 MHz RD moved approximately southward following a cycloidal path characteristic of the superposition of a large-scale drift with motions of near-inertial or tidal nature.

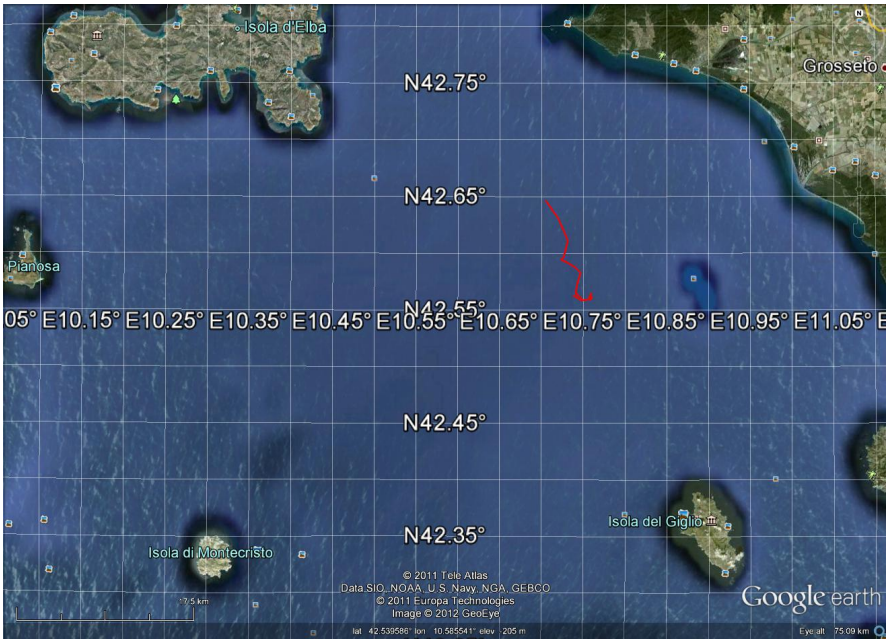

Figure 4: RD track. The RD moved 16.2 nm between October 11, 2011 11:10 UTC and October 13, 2011 09:15 UTC

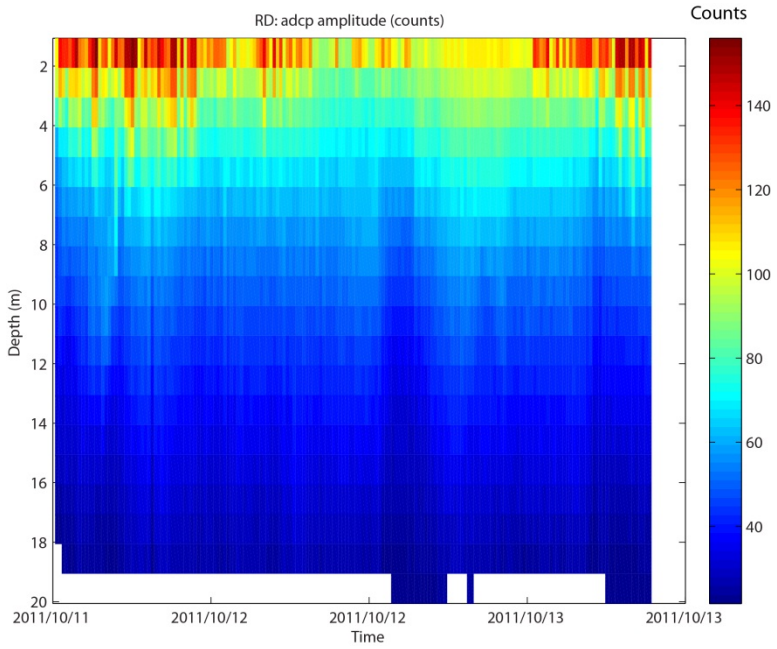

Figure 5: RD onboard ADCP. Acoustic intensity

The good quality of the data is testified by the ADCP amplitude plot. The swift southward drift of the RD at the beginning of its mission is reflected in the negative, southward current measured by the RD's ADCP and corrected for the motion of the instrument, the latter measured with the onboard 1Hz GPS (Figure 4).

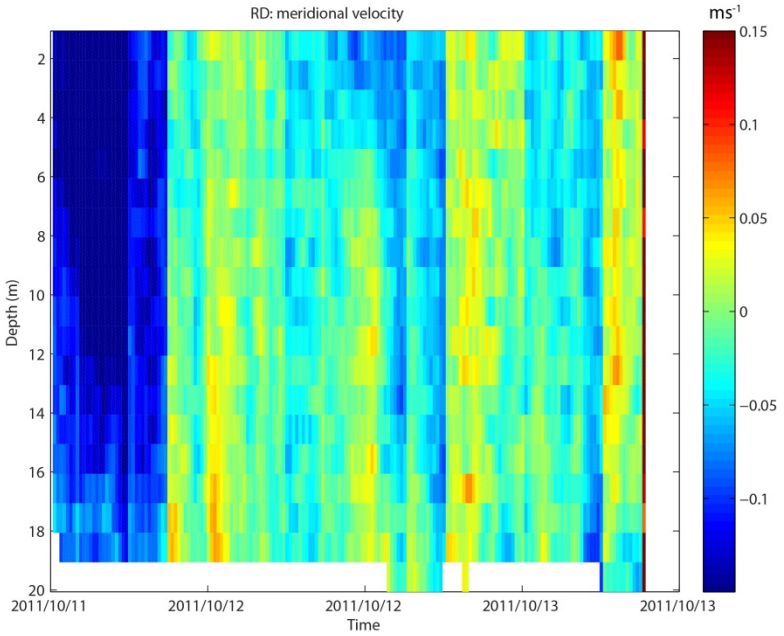

Figure 6: Meridional velocity as measured with the RD onboard ADCP and corrected for the motion of the RD (from the onboard GPS)

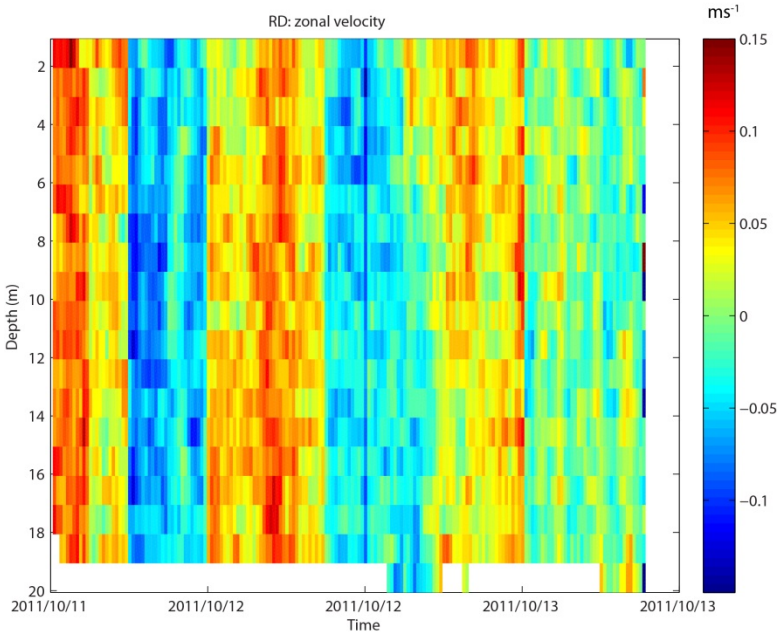

Figure 7: Zonal velocity as measured with the RD onboard ADCP and corrected for the motion of the RD (from the onboard GPS)

Note the periodicity of both the eastward and westward velocity components. Our preliminary analysis suggests a periodicity of about 16.5 hours. Since the inertial frequency at the experiment location is approximately 17.7 hours, the cycloidal RD path and the periodical measured currents should result from near-inertial currents.

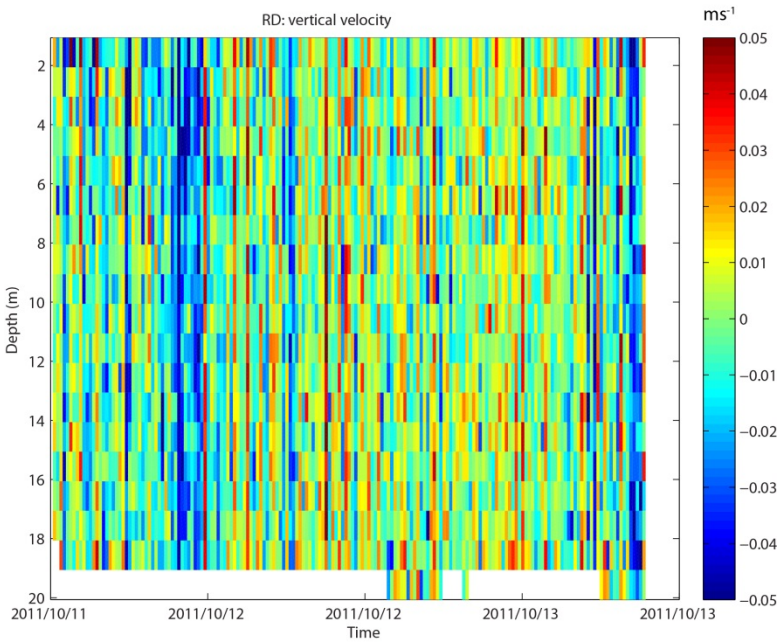

Figure 8: The vertical velocity shows at least three downwelling events, with the strongest one occurring just before midnight on October 11, 2011

After 202 and 162 days respectively, both SVP systems reached their end of life caused by washing ashore. Both drifters were successfully recovered by assisting local oceanographic agencies. An assessment was made regarding condition of the re-sealable hull, drogue assembly, as well as power consumption.

SVP #1 (202 days drifting) reached its end of life by washing ashore in Grosseto, Italy.

Figure 9: Drifting path of SVP #1

Collaborating oceanographers were contacted, recovered the drifter, and provided SIO with an assessment of the hardware. The battery pack starting voltage was 12.16VDC with a final battery voltage of 11.20VDC as measured by the controller.

River Drifter technology
The river drifter is now ready to be employed in the Vietnam DRI should the need arise.

SVP drifter assembly
Our lab is now ready to produce large number of SVP drifters in support of ONR activities.

IMPACT/APPLICATIONS

We hope to be able to use the River Drifter in future studies of shallow water bodies as the combination of Lagrangian velocity, 3-D vertical profiles and bathymetry data represents a novel approach in the study of the hydrodynamics of estuaries and lagoons.

RELATED PROJECTS

Vietnam DRI